SECTION 8

HEALTH AND SAFETY CONSIDERATIONS

8.1 General Discussion

Activities undertaken to close USTs and to investigate and clean up releases, pose potential health and safety threats to the public and to personnel conducting these activities. The types of activities undertaken at UST sites can include excavating USTs; cutting USTs; hauling, treating, storing, and disposing of flammable and combustible materials; cleaning the interior of USTs; and working in confined spaces that may be oxygen-depleted and/or have explosive atmospheres. Owners and operators and their consultants/contractors should be informed that there are Federal and State health and safety requirements with which all workers, including consultants/contractors, must comply while undertaking various activities at a UST site. The Federal UST regulations refer to several publications, industry consensus codes, and standard practices that must be followed when undertaking UST activities (see Section 9). In addition, the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) has established regulations (Title 29 CFR Part 1910, Section 120, Hazardous Waste Operations and Emergency Response) that must be followed by individuals performing emergency response and cleanup activities for hazardous substances, including petroleum (see summary discussion in Appendix 8-A). The State of Hawaii has established a similar regulation, Hawaii Administrative Rules (HAR) Title 12, Chapter 104, Permit-Required Confined Spaces. A related chapter which must be followed is HAR Title 12, Chapter 203, Hazard Communication.

In Hawaii, the Division of Occupational Safety and Health (DOSH), a division of the Department of Labor and Industrial Relations, is the agency that monitors and enforces compliance with worker health and safety requirements. Owners and operators and their consultants/contractors should contact DOSH for more information on these requirements. Owners and operators and their consultants/contractors are expected to comply with all worker safety and health standards that may apply to a UST site. Prior to conducting any field activity, health and safety concerns should be specifically

identified for the site, and as appropriate, health and safety procedures should be set forth in a Site Health and Safety Plan (SHSP) written specifically for the site (see Appendix 8-B). All site workers must have appropriate and current health and safety training and certifications. The health and safety of both the UST worker (Subsection 8.2) and the public (Subsection 8.3) are discussed in this section of the guidance manual. As a general guide to the potential hazards associated with UST work, Table 8.1 shows various UST activities and the health and safety considerations associated with each activity.

8.2 Worker Safety

Any work performed in or around a UST involves some degree of risk. This risk can be minimized, however, by following proper health and safety procedures. This subsection addresses worker safety issues such as personal protective equipment (PPE) required for different conditions encountered at a UST site.

UST workers should be constantly aware of not only the UST and its surroundings, but also the nature of the substance(s) stored in the UST. Gasoline is the petroleum product most commonly stored in USTs and is a highly volatile, non-uniform blend of organic liquids composed of numerous constituents. Table 8.2 lists some of the constituents of concern and their potentially harmful health effects for both gasoline and other petroleum products. Of the constituents listed, aromatic and alkane chemical groups may be responsible for most adverse health effects. The aromatic fractions of gasoline, namely benzene (4-10%), have carcinogenic properties and thus pose the most serious health risk. Other aromatics in gasoline such as ethylbenzene, xylene, toluene, and naphthalene, while not known carcinogens, should be considered hazardous and treated as such. Some alkanes such as hexane and octane are associated with central nervous system depression and kidney damage. Gasoline additives such as tetramethyl lead (TML), tetraethyl lead (TEL), ethylene dibromide (EDB), ethylene dichloride (EDC), and tri-ortho-cresyl phosphate (TOCP) may have delayed symptoms of exposure for up to eight days. While their concentrations in

Table 8.1 Health and Safety Considerations Associated with UST Activities

Activities	Health and Safety Considerations											
	Heavy Lifting	Electro-cution	Fire/ Explosion	Burns/ Contact Heat	Vapor Inhala-tion	Dust Inhala-tion	Skin Absorp-tion	Confined Spaces	Suffo-cation	Machi-nery Injuries	Excess-ive Noise Exposure	Falling Objects
Installation												
Excavation	X	X	X	X	X	X	X	X		X	X	X
Material Handling	X	X	X	X	X		X	X	X			X
Tank Testing												
Use of Hand Tools			X							X		
Use of Adhesives/Dope					X		X	X				
Back Filling/Compacting	X	X				X				X	X	X
Petroleum Release Investigations												
Removal of Contaminated Soil	X	X	X	X	X	X	X			X	X	X
Product Handling			X		X		X					
Basement/Sewer Investigation		X	X		X	X	X	X	X			X
Testing												
Product Handling			X		X		X					X
Use of Hand Tools			X		X							

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Closure												
Product Transfer	X		X	X	X		X			X		X
Material Handling			X		X		X		X	X		X
Use of Hand Tools			X		X		X			X		X
Removal												
Excavation	X	X	X	X	X	X	X	X	X	X	X	X
Removal of Contaminated Soil	X	X	X	X	X	X	X		X	X		X
Repair												
Product Transfer	X	X	X		X		X			X		X
Sand Blasting	X		X		X	X		X	X	X	X	
Application of Epoxy Chemicals			X		X		X	X	X			
Monitor Well Installation												
Removal of Contaminated Materials	X	X	X	X	X	X	X			X	X	X
Product Handling		X	X		X	X	X			X		X

Table 8.2 Some Constituents of Petroleum Products and Their Adverse Health Effects

PRODUCT	CONSTITUENT	POTENTIAL HEALTH EFFECT
Gasoline	Benzene	Human carcinogen
	Toluene	Causes disorientation
	Xylenes	Toxic to central nervous system (CNS)
	Ethylbenzene	Toxic to liver, kidneys, and CNS
	Methyl Tertiary-Butyl Ether	Possible human carcinogen
	Ethylene dibromide	Probable human carcinogens
	Ethylene dichloride	
	n-Hexane	Causes dizziness, nausea, vomiting; irritates eyes and mucous membranes
Middle Distillates (Aviation fuels, kerosene, diesel, and fuel oil Nos. 1 and 2)	**Polynuclear aromatic hydrocarbons (PAHs)**	
	Naphthalene	Causes malaise, tremors, and vomiting
	Benzo(a)anthracene	Probable human carcinogen
	Benzo(a)pyrene	Probable human carcinogen
	Octane	Irritates skin and mucous membranes
	Cresols and Phenols	Irritates eye, skin, mucous membranes
	N,N-dimethylformamide	Irritates eyes, mucous membranes, and skin
	Manganese compounds	Affects central nervous system
Residual Fuels	**PAHs**	
	Benzo(a)anthracene	Probable human carcinogen
	Benzo(a)pyrene	Probable human carcinogen
	Catalytically cracked clarified oil	Potent carcinogen in animals
	Chrysene	May be a carcinogen

gasoline are relatively low compared to benzene, toluene, and xylene (BTX), they are highly toxic and any symptoms should be closely monitored. However, with the proper PPE and adherence to all safety guidelines, the possibility of exposure to hazardous materials is minimized.

8.2.1 Personal Protective Equipment

OSHA has established four levels of personal protective equipment (PPE) for specific degrees of protection. These four levels are designed to give workers a certain measure of safety against work hazards and protection primarily against dermal and inhalation exposures to various substances which could pose a health threat to the worker without such protection. Owners and operators and their consultants/contractors should refer to HAR Title 12, Chapter 64.1 (DOSH), and OSHA 1910 Subpart I - Personal Protective Equipment 1910.132 through 1910.38 for a description and discussion of the levels of protection.

LEVEL A

- Supplied-air respirator approved by National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA)
- Fully encapsulated chemical suit
- Gloves (inner), chemical-resistant
- Boots, chemical-resistant, steel-toe and shank
- Disposable gloves and boot covers
- Two way radio communications (intrinsically safe)

Level A protection is the highest level of protection for both skin and respiratory tract. Level A protection is not expected to be used at most UST sites.

LEVEL B

- Supplied-air respirator (NIOSH/MSHA approved)
- Chemical-resistant clothing (coveralls and long sleeve jacket; hooded, one or two piece chemical-splash suit; or disposable chemical-resistant one piece suit);
- Gloves (both inner and outer), chemical-resistant
- Boots (outer), chemical-resistant, steel-toe shank
- Two way radio communication (intrinsically safe)

Level B protection is to be used where the highest level of respiratory protection is needed, but less-than-severe hazard to the skin. Level B protection may be needed at

UST sites where high concentrations of hydrocarbon vapors might be encountered, such as inside the UST.

LEVEL C

- Air-purifying respirator, full face, canister equipped (MSHA/NIOSH approved)
- Chemical-resistant clothing (coveralls; hooded, one-piece or two-piece chemical splash suit; chemical-resistant hood and apron; disposable chemical-resistant coveralls
- Gloves (both inner and outer), chemical-resistant
- Boots (outer), chemical-resistant, steel-toe and shank
- Hard hat (face shield)
- Two way radio communication (inherently safe)

Level C protection is the most common level of PPE worn at UST sites where moderate levels of hydrocarbon vapors are present.

LEVEL D

- Coveralls
- Boots, shoes, leather or chemical resistant; steel-toe and shank
- Hard hat
- Eye protection

Level D protection is simply a work uniform and should only be worn when there is no danger of being exposed to any respiratory or skin hazards.

8.2.2 Specific UST Activities of Concern for Workers

8.2.2.1 UST Entry

One of the most dangerous UST activities is tank entry. Individuals who intend to enter any UST are expected to comply with all pertinent Federal, State, and County requirements regarding such activity. Specific requirements are given in 29 CFR 1910.146, Permit-Required Confined Spaces (OSHA Standards), and HAR Title 12,

Chapter 104, Permit-Required Confined Spaces (DOSH Standards), and the most current edition of American Petroleum Institute (API) 1604 Recommended Practice for Abandonment or Removal of Used Underground Service Station Tanks and API 2015 Cleaning Petroleum Storage Tanks documents.

The dangers associated with UST entry include:

- Fire
- Explosion
- Poisoning
- Asphyxiation
- Structure Failure

Because any of these dangers could potentially be life threatening, certain precautions should be followed prior to a UST entry. These precautions are:

- Develop a Site Health and Safety Plan (SHSP)
- Brief workers before entry
- Inspect space before entering
- Use the buddy system
- Ventilate hazardous atmospheres
- Use appropriate personal protective equipment and proper tools
- Continuously monitor conditions
- Know proper rescue procedures and equipment

No one should enter a UST unless a SHSP has been completely laid out (see Appendix 8-B), and all those involved with the entry completely briefed. The UST should also be inspected for structural integrity. The SHSP should specify all existing and potential hazards, and measures necessary to ensure worker safety and health.

The UST should be ventilated of hazardous atmosphere prior to entry and continuously monitored for explosive and oxygen deficient atmospheres throughout the entire entry event. As a general rule, venting should be performed twelve feet above grade and three feet above adjacent roof tops. PPE must be worn before attempting to enter the UST.

The "buddy system" should be followed during UST entry. There should be a minimum of two workers outside the UST when work inside the UST is being performed. One worker should be the designated safety person and stand directly outside the UST while the other worker maintains visual or audio contact with both the worker inside the UST and the safety person. A safety harness must be worn at all times while entering the UST. The safety line should be secured to a well anchored object and tended to by the safety person.

All tools and equipment brought into the UST should be non-sparking and certified as "intrinsically safe." Tool selection and use should be in compliance with OSHA (29 CFR 1910 Subpart S) regulations. All items should be bonded and grounded where possible.

In the event of an emergency, contact Emergency Response (911) immediately and refer to the SHSP to notify all proper authorities. **Do not attempt a rescue without proper training and appropriate PPE.** As a general rule, rescue workers should wear Level B protection.

8.2.2.2 Excavations and Trenches

Another dangerous UST activity is excavation work. Cave-ins are the primary hazard to a worker at an excavation site. Cave-ins occur when the soil forming the sides of the excavation or trench becomes unstable and fails. Methods used to prevent cave-ins consist of sloping the sides of the trench or excavation, placing a shield between the sides of the work area, and shoring up the sides with supports. All excavations over four feet deep should employ either sloping or shoring unless the banks are sloped to the angle of repose. Prior to the start of an excavation, necessary barricades, walkways, lighting, and postings should be provided for the protection of the public and workers. Ladders shall be provided that reach from the bottom of the excavation to a height of three feet above grade, requiring no more than twenty five feet of lateral travel. For specific requirements refer to 29 CFR 1910.146, Permit-

Required Confined Spaces (OSHA Standards), and HAR Title 12, Chapter 104, Permit-Required Confined Spaces (DOSH Standards).

8.2.2.3 Cutting and Welding USTs

The danger involved with cutting and welding USTs is the potential for fire and explosion. There are a number of precautions that should be taken before any cutting or welding is performed on a UST. These precautions include controlling one or more of the three components required for combustion: fuel, oxygen, and a source of ignition.

Two ways of bringing the fuel-oxygen mixture to a non-combustible level are **purging** and **inerting**. Purging is the process of diluting the flammable vapors in the UST with air, thus reducing the fuel portion of the flammable mixture. As a safety precaution purging should never exceed 5 pounds per square inch. Purging is temporary in nature however, because product that is trapped in the sludge and wall scale can regenerate flammable vapors inside the UST. Therefore, frequent or continuous monitoring at all pertinent locations such as inside the UST, in the excavation, and any other below grade levels is required.

The process of inerting controls the amount of oxygen present in the UST by reducing the oxygen concentration in the UST to below the 12-14% needed for combustion of petroleum products. This is accomplished by displacing the oxygen with an inert gas, usually nitrogen, or by using dry ice (carbon dioxide, CO_2). The recommended ratio of dry ice poundage to UST capacity is 1.5 pounds dry ice per 100 gallons. **NOTE: Inerting creates an oxygen deficient atmosphere. Entry into USTs following inerting must be made with an air supplying respirator.**

Another way to reduce the potential for fire or explosion is to **control the source of ignition**. Sparks are sources of ignition and can be generated by the use of electrical

equipment, striking the UST with a metal object, or simply induced by static electricity.

In addition to combustion, another concern is associated with welding USTs. Welding can produce toxic gases. Arc welding done near chlorinated compounds can produce phosgene, a highly toxic gas. Galvanized zinc and copper alloys can also release toxic gases when welding is performed on a UST.

8.2.2.4 Remediation and Closure

Persons involved with cleaning up contaminated sites can potentially be exposed to petroleum constituents which poses a health threat, particularly benzene. The three main routes of exposure are: inhalation, skin absorption, and ingestion. Generally, inhalation is the most rapid means for a substance to enter and affect the body. Signs and symptoms of exposure must not be ignored. Necessary precautions to minimize exposure should be taken by using appropriate personal protective equipment and following all safety guidelines.

For UST closures, proper health and safety procedures should be followed when entering a UST. Health and safety procedures should also be followed when removing sludge and sediment and cleaning the UST.

In cases where USTs are to be cleaned offsite, no USTs should be transported away from the site without first being purged or inerted. Inadequately purged or inerted USTs literally can act as potential moving "bombs" on the road. USTs should be removed from the site as soon as possible after purging or inerting procedures are completed because additional vapor may be regenerated from any remaining liquid, sludge, or scales in the UST. As a general rule, prior to transport, the UST should be checked with an explosimeter to ensure that 20% of the lower explosive limit (LEL) is not exceeded.

Table 8-1 lists some of the remediation and closure activities at a UST site and the types of health and safety hazards which are likely to be encountered.

8.3 Public Safety and Site Access Control

8.3.1 Community Considerations

In addition to the safety considerations for the onsite worker, UST activities may present hazards to the surrounding community. The UST owner and operator should take specific steps to prevent or control the spreading of contamination and the potential for physical and health hazards to the public. The owner and operator should ideally inform the community of the existence of potential health and safety hazards posed by release response and closure activities at the site. Both the health and safety of workers and the surrounding community should be addressed in the development of a Site Health and Safety Plan.

8.3.2 Site Security and Access Control

Site security is important to prevent unauthorized personnel and the public from the site and its potential hazards. Often this is achieved by erecting a fence or other barrier which completely surrounds the site. In addition, signs should be posted around the perimeter informing passersby of the potential hazards. The signs should ideally be placed at each entrance to the site and at other locations in sufficient numbers to be seen from any approach to the site. Signs should be legible and readable from a distance of at least 25 feet. For sites undergoing long-term remediation, suggested sign language should read: "Caution - Petroleum Contamination - Unauthorized Personnel Keep Out". In cases of UST removals the signs should read: "Caution - Underground Tank Removal in Progress - Unauthorized Personnel Keep Out".

In some cases, UST owners and operators may choose to post security guards or implement other 24-hour surveillance systems at the site. If a site poses a significant risk to the community, the police department and local fire authority should be alerted so that in the event of an emergency, appropriate assistance is readily available. To further enhance site security, equipment and machinery should be locked up behind a fence or removed from the site during off-hours.

Maintaining access control at the site should also be implemented along with site security. This involves establishing a personnel control system to effectively identify authorized personnel and to specify any restrictions to a person's onsite activities. This is obviously more appropriate to larger, more complicated job sites.

8.3.3 Environmental Monitoring and Controls

Ambient air measuring points can be established both within work zones and around the perimeter of the site. Air measuring devices can monitor for contaminant migration offsite and the potential for exposing the public to contaminants. In the event that airborne contaminant levels are not acceptably safe, work activities should be halted or minimized until the source(s) of the airborne contaminants is effectively controlled and air emissions are reduced to acceptable levels. Sources of airborne contaminants can be effectively controlled using various methods and techniques such as erecting berms and dikes, using sorbents, wetting, using foams and vapor barriers, and using fans and blowers. Even selectively choosing the time of day or season of the year or the weather conditions can have a dramatic effect on air emission levels.

The Project Coordinator should also be on the alert to quickly respond to the movement of any contaminated water offsite. Typical examples of this are rainfall runoffs, washouts, overwatering, failure of containment controls, and untreated water being pumped out to storm drains, street gutters, etc. Many of these releases can be prevented by good engineering or effectively controlled by strategically planning for responses to these events (i.e., contingency planning).

8.3.4 Emergency Response Planning

All UST sites have potential hazards that could require emergency response. To address this, it is necessary to develop an emergency response plan as part of the Site Health and Safety Plan, and this plan should include protecting the public as well as the site workers (see Appendix 8-B). Key elements of such a plan include provisions for: notification, emergency alert, evacuation procedures, and emergency equipment. The emergency response plan is prepared with protection of the public and site workers as the highest priority (followed by protection of the environment and protection of property).